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ABSTRACT

The Test of Enquiry Skills (TOES) is a group test designed to measure inquiry skills of junior high school students studying science, social sciences, or general studies. TOES is comprised of nine separate scales, each consisting of multiple-choice items. The following skills are measured: reference skills, including library usage, indexes and tables of contents; interpreting and processing information, including scales, averages, percentages and proportions, charts and tables, and graphs; and critical thinking in science, including comprehension of science reading, design of experimental procedures, and conclusions and generalizations. In addition to the test, the handbook is included and contains information on the scope, administration, scoring, and use of TOES as well as statistical information on samples, means, standard deviation, reliability, and percentage correct on each item. Instructions for administration and scoring, the score key, and answer sheet are appended. (MH)

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Introduction

Test Of Enquiry Skills (TOES) is designed to measure enquiry skills among junior high school students studying science, social science (including social studies, geography or history) or general studies. There are nine separate scales in TOES, each consisting of multiple-choice items suitable for group administration. TOES has been carefully developed and extensively field tested and has been shown to be reliable. This handbook includes a description of background information, statistical data for Year 7–10 samples, and possible uses of TOES. Appendix I contains detailed instructions for administration and scoring, Appendix II contains the score key, and Appendix III contains a copy of a student Answer Sheet which may be reproduced without copyright restrictions.

Acknowledgments

While the co-operation of numerous colleagues, about a hundred teachers, and over two thousand school students is gratefully acknowledged, space permits specific reference only to the following handful of people who provided valuable assistance with the initial conception of the test, in scrutinizing earlier versions of items or in commenting on earlier manuscripts on which this handbook is based: Neil Baumgart, Leslie Dale, Marjorie Gardner, Paul Gardner, William Hall, Clive Kings, Russell Linke, Lindsay Mackay, Jack Merwin, Ken Moritz, Gregor Ramsey, John Theobald, Ian Thomas, and Richard White.

Background

In recent times, there has been a pronounced movement in science and social science education at the junior high school level towards teaching approaches emphasizing enquiry and individualization. These approaches involve the student in active learning based on investigation and allow different students within a given class to work simultaneously at different rates and to follow alternative paths compatible with their interests and abilities. This trend towards enquiry and individualization is reflected in the ideals of open education (Barth & Rathbone, 1971; Walberg & Thomas, 1972) and in numerous overseas curriculum packages in science (see Hurd, 1970) and social science (see Marsh & Print, 1975). Furthermore, emphasis on enquiry and individualization is evident in major Australian curricula such as the Australian Science Education Project (ASEP, 1974) and the Social Education Materials Project (SEMP, 1977).

Associated with this trend towards enquiry and individualization, there has been a growing awareness of the importance of enquiry skills (Postman & Weingartner, 1969; Newport, 1972). Firstly, students' low proficiency at certain skills (such as using references or interpreting graphical information) could limit their effectiveness in using enquiry and individualized materials and, therefore, reduce their chances of gaining the understandings or attitudes which were intended. Secondly, a commonly stated aim of enquiry and individualized teaching approaches is the promotion of increased student proficiency at various enquiry skills. Consequently, a test measuring enquiry skills would be potentially useful for checking whether students or classes possess an adequate level of proficiency at various skills prior to beginning an enquiry or individualized teaching strategy, and for monitoring student progress towards important skill aims. In particular, since different students following individualized curriculum materials in the same classroom can cover quite different content areas, tests of enquiry skills (which are content-free) may provide a more useful means of monitoring student progress than conventional achievement tests which assume coverage of specific content (Goldberg, 1970). Furthermore the potential usefulness of an instrument to measure enquiry skills is highlighted further by the fact that teachers using ASEP materials commonly experience problems with assessment. These problems with assessment among ASEP teachers are well documented, both in reports delivered by representatives from each Australian State and Territory at a recent conference convened by the Curriculum Development Centre (CDC, 1977), and in Owen's survey of a national sample of 1004 ASEP teachers which revealed that 'assessment is a major problem confronting teachers in schools' (Owen, 1977, p.161).

Scope of TOES

An overview of the scope of the enquiry skills measured by TOES is provided in Table 1. Altogether TOES measures nine separate enquiry skills which fall into three major groups. The first group of scales (Part A) measures skills related to using reference materials such as dictionaries, encyclopaedias and library catalogues (Skill 1), or a book's index and table of contents (Skill 2). The second group of four scales (Part B) measures the following skills related to interpreting and processing information: reading various scales (Skill 3), calculating averages, percentages and proportions (Skill 4), interpreting charts and tables (Skill 5) and using graphical materials (Skill 6). The third group of scales (Part C) measures three critical thinking-in-science skills, namely comprehension of science reading material (Skill 7), design of experimental procedures in science (Skill 8), and the ability to draw valid conclusions and generalizations from data (Skill 9). Further details about the specific skill aims measured by each TOES scale can be acquired by examining the actual items contained in the scales.

Table 1 Scope of TOES

	Scale	No. of items	School subjects
Part A –	Using Reference Materials		Science and Social Science[a]
Skill 1:	Library usage	10	
Skill 2:	Index and table of contents	9	
Part B –	Interpreting and Processing Information		Science and Social Science[a]
Skill 3:	Scales	10	
Skill 4:	Averages, percentages and proportions	8	
Skill 5:	Charts and tables	11	
Skill 6:	Graphs	10	
Part C –	Critical Thinking in Science		Science only
Skill 7:	Comprehension of science reading	10	
Skill 8:	Design of experimental procedures	10	
Skill 9:	Conclusions and generalizations	9	

[a]Social science includes social studies, geography, and history.

Table 1 shows that the average number of items per scale is a little less than 10 and that the whole TOES battery contains 87 items in all. Furthermore, all nine skills and all 87 items are clearly relevant to science teaching. On the other hand, only Skills 1–6 (58 items) are relevant to social science teaching. That is, it is suggested that science teachers use the whole TOES battery while social science teachers use only the first six scales.

Development of TOES

The development of TOES, which has been described in detail elsewhere (Fraser, 1976), proceeded in a number of identifiable stages. First, a comprehensive literature review was used to identify the enquiry skills considered most important by experts in the literature. Second, an initial pool of items was developed and then rewritten in the light of reactions from teachers and experts in educational measurement about each item's clarity, readability, face validity and scale allocation. Third, items were assembled to form a first version which was administered to a sample of approximately 140 Year 7 students in Melbourne. Fourth, a second version was assembled, based on evidence obtained from statistical analysis of data and student interviews associated with the first field trial, and this was administered to a sample of 400 Melbourne Year 7 students. Fifth, a third and final version of TOES was formed by deleting from the second version those items identified as faulty in the analysis of data from the second administration.

Statistical Information for Years 7–10

The final version of TOES was administered to samples of students in Years 7–10 in order to obtain descriptive statistics for each scale and item. The three main scale statistics calculated were the mean, standard deviation, and reliability (see Table 3), while the main item statistic was the percentage of students correct (see Table 4).

Samples*

The samples to which the final version of TOES was administered are described in Table 2 in terms of both the number of schools and the number of students involved at each of the four levels. In all cases, each class was drawn from a different school in an attempt to involve the broadest spectrum of schools possible for a given student sample size. Furthermore, although samples were not randomly chosen for a variety of reasons, every attempt was made to ensure that schools were spread over a wide variety of geographic and socio-economic areas and were representative of larger populations of schools. Similarly, in schools where students were grouped into classes according to ability, particular care was taken to include a variety of ability levels in the samples. Also approximately equal numbers of boys and girls were included in the sample at each level. Except at the Year 7 level where all students provided responses to all TOES items over several different administrations, different random thirds of the students in each class responded to different thirds of the TOES battery. The reasons for employing this sampling strategy at the Year 8–10 levels were to minimize the time commitment required of individual students, to provide the broadest possible coverage of schools for a given student sample size, and to ensure that samples responding to different parts of the TOES battery were comparable. While some caution is needed in interpreting data from the relatively smaller samples in Years 8–10, statistics have been included here to provide teachers with guidance about what level of performance can be expected at different levels.

Table 2 Sample Sizes in Years 7–10

TOES scale	Number of schools in Year				Number of students in Year			
	7	8	9	10	7	8	9	10
Skills 1–3	46	25	12	12	1 158	254	118	121
Skills 4–6	46	25	12	12	1 158	258	122	120
Skills 7–9	46	25	12	12	1 158	264	120	119

The Year 7 sample consisted of 1158 students in 46 different co-educational government high schools in the Melbourne metropolitan area. Furthermore, as each Year 7 student had responded to the TOES scales both as pre-tests at the beginning of the 1974 school year and again as post-tests at the end of the same year as part of another study, it was decided to report the mean of pre-test and post-test statistics as an estimate of the Year 7 statistics at mid-year. While Year 7 students provided responses at both the beginning and end of the year, the Year 8–10 samples responded to TOES at about mid-year. Each sample at the Year 8–10 level consisted of government high, Catholic and other independent schools selected approximately in proportion to the numbers of these schools in the population. While the Year 8 sample responding to different TOES scales consisted of between 254 and 264 students drawn from 25 schools in the Melbourne metropolitan area during 1975, the Year 9 and Year 10 sample consisted of between 118 and 122 students drawn from 12 schools in the Sydney metropolitan area during 1977.

* Data about TOES were collected in Victoria and New South Wales. In these States and in Tasmania and the Australian Capital Territory, where there are six years of secondary school, the first year of secondary school is designated at Year 7. For South Australia, Western Australia and Queensland, where there are five years of secondary school, the first year of secondary school is designated as Year 8.

Table 3 Mean, Standard Deviation, and Reliability of Each TOES Scale at Each Year Level at Mid-year

TOES scale	No. of items	Mean in Year				Standard deviation in Year				KR-20 reliability in Year				Test-retest reliability[a]
		7	8	9	10	7	8	9	10	7	8	9	10	
Skill 1 (Library)	10	5.8	6.4	7.1	8.3	2.2	2.0	1.6	1.5	0.65	0.62	0.58	0.54	0.74
Skill 2 (Index)	9	6.1	7.1	7.7	8.3	2.6	1.8	1.5	1.0	0.79	0.70	0.62	0.51	0.82
Skill 3 (Scales)	10	5.6	6.6	7.8	9.1	2.7	2.4	2.3	1.4	0.77	0.76	0.73	0.60	0.78
Skill 4 (Averages)	8	2.8	4.1	5.1	7.0	2.4	2.4	2.2	1.4	0.78	0.80	0.75	0.64	0.78
Skill 5 (Charts)	11	6.7	7.5	8.3	9.1	2.6	2.2	1.8	1.5	0.72	0.66	0.57	0.57	0.65
Skill 6 (Graphs)	10	5.0	6.4	7.2	8.9	2.9	2.9	2.5	1.7	0.79	0.83	0.77	0.75	0.80
Skill 7 (Comprehension)	10	6.1	6.9	7.6	8.6	2.6	2.4	2.2	1.7	0.69	0.62	0.60	0.55	0.70
Skill 8 (Experimental)	10	5.4	6.0	6.7	7.9	2.2	2.0	1.7	1.5	0.61	0.57	0.53	0.50	0.66
Skill 9 (Conclusions)	9	4.5	4.9	5.4	7.0	2.3	2.4	2.1	1.8	0.69	0.75	0.65	0.62	0.67
Mean of the 9 scales	9.7	5.3	6.2	7.0	8.2	2.5	2.4	2.0	1.5	0.72	0.70	0.64	0.59	0.73

[a]Test-retest reliability coefficients were estimated for different scales using samples of 100–104 Year 7 students.

Year 7 statistics are the means of statistics obtained at the beginning and end of a school year.

The Year 7 and 8 data were collected in Melbourne while the Year 9 and 10 data were collected in Sydney.

Means

Table 3 shows, separately for each grade level, the mean score obtained on each TOES scale and the overall mean of the nine-scale means. These mean values provide guidance about what level of performance can be expected on various TOES scales at different levels. In interpreting the means, however, it should be noted that different TOES scales vary in the number of items contained in a scale, and therefore in the maximum score possible, from eight items in Skill 4 to 11 items in Skill 5. Furthermore, examination of the data in Table 3 indicates that the mean performance at a given level varied markedly from skill to skill. For example, the lowest level of performance at each year level occurred for Skill 4 (mean of 2.8 out of 8 in Year 7), while the highest level of performance at each level occurred for Skill 2 (mean of 6.1 out of 9 in Year 7).

Mean scores in Table 3 also indicate that the average performance on all TOES scales increased with level. In fact, the table shows that the overall mean of the nine-scale means ranged from 5.3 in Year 7, to 6.2 in Year 8, to 7.0 in Year 9, and to 8.2 in Year 10. In interpreting test results for Year 10 students, however, it should be noted that the mean for certain TOES scales was fairly close to the maximum score possible (e.g. a mean of 9.1 out of 10 for Skill 3).

Standard Deviations

The standard deviation of each TOES scale and the mean of the nine-scale standard deviations are shown separately for each year level in Table 3. These values indicate that the TOES scales generally had a reasonable spread of scores at each level. Also one would expect the standard deviation of scales to decrease with level both because the mean score approaches closer to the maximum score possible with level and because the sample size decreases with level. The data in Table 3 indicate that a decrease in scale standard deviation did occur with level, with the mean scale standard deviation ranging from 2.5 and 2.4 for Year 7 and Year 8, respectively, to 2.0 for Year 9, and to 1.5 for Year 10.

Table 4 Percentage of Students Correct on Each TOES Item at Each Year Level at Mid-year

Item	% correct in Year 7	8	9	10	Item	% correct in Year 7	8	9	10	Item	% correct in Year 7	8	9	10
Skill 1					Skill 4					Skill 7				
1	58	66	76	85	**30**	37	66	79	95	**59**	71	80	83	95
2	69	73	74	91	**31**	35	60	77	93	**60**	46	54	69	79
3	85	90	96	96	**32**	28	50	58	83	**61**	19	21	24	44
4	79	84	89	96	**33**	28	38	48	87	**62**	87	94	97	99
5	52	59	68	85	**34**	76	80	83	94	**63**	74	81	88	94
6	71	77	89	95	**35**	37	50	61	93	**64**	75	82	90	94
7	24	29	40	55	**36**	19	35	54	79	**65**	78	85	92	99
8	70	71	76	80	**37**	19	35	45	74	**66**	81	88	94	100
9	27	32	40	62						**67**	39	53	62	75
10	48	57	71	87						**68**	43	52	63	82
Skill 2					Skill 5					Skill 8				
11	64	76	79	92	**38**	73	79	86	96	**69**	36	39	43	62
12	72	84	89	94	**39**	23	28	34	36	**70**	38	43	49	58
13	71	85	93	96	**40**	73	75	77	86	**71**	61	70	84	87
14	46	60	69	79	**41**	85	90	96	96	**72**	79	85	91	99
15	60	74	84	95	**42**	69	75	87	92	**73**	29	30	47	69
16	79	88	96	97	**43**	56	68	77	87	**74**	67	76	87	98
17	70	76	86	95	**44**	60	66	83	95	**75**	43	45	47	75
18	71	82	90	94	**45**	41	50	54	66	**76**	80	85	92	93
19	72	81	86	91	**46**	40	51	59	70	**77**	54	65	71	66
					47	75	85	94	96	**78**	52	60	63	82
					48	72	80	82	93					
Skill 3					Skill 6					Skill 9				
20	58	66	76	92	**49**	56	70	82	93	**79**	68	72	77	94
21	70	77	86	96	**50**	58	76	83	92	**80**	69	77	88	92
22	74	82	91	95	**51**	43	60	69	89	**81**	39	42	44	73
23	64	69	87	96	**52**	59	68	73	91	**82**	51	55	59	68
24	41	50	64	82	**53**	48	70	82	94	**83**	38	41	44	65
25	65	77	89	93	**54**	49	60	66	86	**84**	52	60	64	79
26	26	38	55	78	**55**	48	66	74	93	**85**	73	77	82	92
27	52	67	80	94	**56**	58	61	63	88	**86**	16	23	30	52
28	48	60	69	87	**57**	42	62	71	90	**87**	49	47	47	82
29	59	74	84	96	**58**	35	49	55	72					

Reliability

The internal consistency reliability (the extent to which items in a given scale measure the same skill) was estimated for TOES scales using the Kuder-Richardson Formula 20 (KR-20). Table 3 shows, separately for each level, the KR-20 coefficient for each TOES scale and the mean of the nine scale coefficients.

The values of KR-20 reliability ranged from 0.61 to 0.79 with a mean of 0.72 for the Year 7 sample, from 0.57 to 0.83 with a mean of 0.70 for the Year 8 sample, from 0.53 to 0.77 with a mean of 0.64 for the Year 9 sample, and from 0.50 to 0.75 with a mean of 0.59 for the Year 10 sample. It should be noted that, as would be anticipated in view of the fact that the standard deviation tends to decrease with level, there is also

some decrease in the sizes of the KR-20 reliabilities with level. Nevertheless, the values of the KR-20 reliability coefficients are generally quite good for scales whose lengths range from only eight to eleven items, and all values are sufficiently high to indicate satisfactory internal consistency reliability for all TOES scales at each level.

The last column of figures in Table 3 provides data about the test-retest reliability obtained for each TOES scale when different scales were administered to samples of between 100–104 Year 7 students in Melbourne on two separate occasions two weeks apart. The table shows that these values ranged from 0.65 to 0.82 and had a mean of 0.73 for the nine scales, thus indicating that all TOES scales displayed quite good test-retest reliability.

Percentage Correct on Each Item

Table 4 shows the percentage of students at each level who answered each TOES item correctly. For example, for Skill 1 at the Year 7 level, Table 4 indicates that students generally found Item 7 very hard (with only 24 per cent of students correct) but found Item 3 relatively easy (with as many as 85 per cent of students correct).

Further Data

In addition to data reported already, some other relevant information is available. For example, a recent administration of different TOES skills to samples of between 201 and 234 Year 6 students in primary schools in the Sydney metropolitan area provided evidence of the potential usefulness of TOES at the Year 6 level. This administration revealed that the overall mean of the nine-scale means was 4.5, whilst scale KR-20 reliabilities had satisfactory magnitudes ranging from 0.50 to 0.75 with a mean of 0.66. As well as data on the nine individual TOES scales, analogous statistics have been computed for the three total scores designated in Table 1 as Part A: Using Reference Materials (Skills 1 and 2), Part B: Interpreting and Processing Information (Skills 3–6), and Part C: Critical Thinking in Science (Skills 7–9). For the 1158 students in the Year 7 sample, the KR-20 reliability estimate obtained by averaging pre-test and post-test coefficients had the quite high value of 0.83 for the 19 items in Part A, 0.90 for the 39 items in Part B, and 0.84 for the 29 items in Part C.

Also data related to the discriminant validity (the extent to which a given scale measures a unique skill not measured by other scales in the battery) of TOES scales were calculated for the Year 7 sample of 1158 students. It was found that scale intercorrelations (averaged over the two administrations) ranged from 0.30 to 0.56 with a mean of 0.47. Although some of these scale intercorrelations are reasonably large, all values are still somewhat smaller than the square root of the product of the corresponding scale reliabilities, which would be the value representing perfect conceptual equivalence (Block, 1963). It was agreed by the teachers and measurement experts involved in the development of TOES that a reasonable relationship between performance on different skills was to be expected, and that it was both justifiable and useful to maintain all TOES scales as separate scales rather than attempting to amalgamate some scales because scale intercorrelations were fairly large.

Administration Time

No time limits apply to the administration of TOES. Instead students should normally be allowed as much time as they need. Nevertheless, when administering TOES to whole classes, teachers might sometimes find it impractical to hold up the whole class while one or two exceptionally slow students complete the test.

The amount of time required to administer TOES varies with the year level, ability levels, reading skills, etc. of the particular class involved. Also, administration time would differ for science students who would answer all nine scales, and for social science students who would answer only the first six scales. Furthermore, for some classes of students, it would be preferable to spread administration over a number of different occasions in order to avoid the excessive student fatigue and disruption to school timetables associated with attempting to administer all scales at one sitting.

Table 5 provides suggestions about the number of separate occasions over which the administration of TOES should be spread in order to minimize student fatigue at different year levels. For social science students (who would answer Skills 1–6), Year 9 and 10 students would normally be capable of answering all six scales at a single administration, while two separate occasions (with three skills on each) would normally be preferable for Year 7 and 8 students. For science students (who would answer all nine scales), it is suggested that two separate administrations (with about half the scales on each) would normally be preferable for Year 9 and 10 students, while three separate administrations (with three scales on each) would normally be preferable for Year 7 and 8 students.

Table 5 provides estimates of the approximate amount of time required for administration on each occasion if suggestions for the numbers of different administration occasions were followed. These estimates, which vary considerably with the ability of students, are based on the minimum and maximum times which were actually needed in the classes described in Table 2 for virtually all students to complete the scales listed in Table 5. For example, Table 5 suggests that social science students in Year 9 and 10 could respond to Skills 1–6 on a single occasion of between 30–75 minutes duration, whereas science students at the Year 7 and 8 level would require three separate occasions of 30–60 minutes duration to complete all nine scales.

Table 5 Suggested Number of Occasions and Times for Administration at Different Year Levels

Year level	Social Science			Science		
	No. of different occasions	Skills on each occasion	Time at each occasion (minutes)	No. of different occasions	Skills on each occasion	Time at each occasion (minutes)
Years 9–10	1	Skills 1–6	30–75	2	Skills 1–5 Skills 6–9	35–65 35–65
Years 7–8	2	Skills 1–3 Skills 4–6	30–60 30–60	3	Skills 1–3 Skills 4–6 Skills 7–9	30–60 30–60 30–60

Administration and Scoring

It is important when administering TOES to follow the instructions for administration carefully. For convenience and easy reference, detailed instructions for administering and scoring TOES have been placed at the end of this handbook in Appendix I. Score keys for all TOES scales are provided in Appendix II. The Answer Sheet is shown in Appendix III.

Uses of TOES

There are numerous ways in which TOES might be used by teachers, curriculum evaluators or researchers for the two main purposes delineated previously, namely monitoring student progress towards achieving skill aims and assessing entry-level skill proficiency. Furthermore, for each of these two major purposes, TOES could be used for providing information about the average performance of groups of students (e.g. in curriculum evaluation) or the performance of individual students. Since many contemporary science and social science curricula emphasize skill aims, it is important to use skill tests as well as conventional tests of content achievement. Furthermore, because different students following individualized materials in the same classroom cover different content, tests of content-free enquiry skills provide a convenient way of monitoring student progress on aims which are applicable to all students irrespective of the specific content covered. Moreover, in employing TOES to monitor student progress on skill aims, it could sometimes be advisable to administer TOES both as a pre-test and a post-test (for example, over the time of a school term or year) in order to obtain information about changes in student performance. Since many enquiry-based teaching strategies and curriculum materials in science and social science are based on the assumption that students possess a certain level of proficiency at skills such as using reference materials or interpreting graphical information, TOES would also be useful for measuring the skill attainment of students at the start of a school year or the beginning of a teaching sequence. This information could then be used by the teacher in selecting appropriate teaching strategies or curriculum materials for a class, or in planning remedial instruction to overcome skill deficiencies.

A major advantage that TOES has over ordinary achievement tests is that it yields a separate score for a number of distinct skill aims instead of a single overall score (see Cronbach, 1963). This makes it possible to obtain for each student or group a *profile* of skill performance similar to those depicted on the grid on the back of the student Answer Sheet (see Appendix III). In fact, the four profiles shown represent the mean scale scores obtained by the samples (Table 2) involved in the field testing of TOES at the Year 7–10 level.

In interpreting the profile of TOES scores obtained by a particular individual or group, it could prove useful to draw the particular profile of scores on the grid provided on the back of the student Answer Sheet. Since this grid already includes a profile of the mean scores obtained at mid-year at each level (Table 3), it can be readily ascertained whether the performance of a particular individual or group is above or below the mean for that grade. Also, by plotting both an individual's profile and the class mean profile on the same grid, it is easy to depict simultaneously the performance of an individual relative to his class and the performance of the class relative to the mean at that level.

Of course, teachers should not necessarily be satisfied just because particular students' scores are somewhat higher than the mean for their year level. Instead, the desirable level of skill achievement would need to be decided in the light of the purpose of giving the test, the nature of the students, the importance of a particular skill for the subject being taught, the time of the school year when the test was administered, etc. For example, in certain situations where mastery is considered important, a score near the maximum scale score could be set as a criterion. In other circumstances, where progress in monitored over time, the amount of improvement between two successive administrations could be more important than the actual level of achievement.

Although previous comments in this section have focused on the use and interpretation of the total scores obtained on TOES scales, information about performance on individual TOES items could also be valuable. Often it is of interest to know, not only how many items a student answers correctly, but also which specific items are answered incorrectly. For example, an examination of an individual's performance on individual items in Skill 1 could enable the diagnosis of deficiencies in specific skills such as using an encyclopaedia or library catalogue and, in turn, this information could be used as a basis for planning individual remedial instruction for the student. Similarly, examination of the average performance of a whole class on individual TOES items could lead to the identification of common skill deficiencies which could be overcome through group remedial instruction. Furthermore, in interpreting data on the number of students correctly answering individual TOES items, some useful comparisons could be made with the data of Table 4 showing the percentage of students who answered each TOES item correctly at each level in the field trials.

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APPENDIX I

Test Of Enquiry Skills (TOES)

Instructions for Administration and Scoring

Prior to administration

1 Determine the number of different testing occasions required according to year level, student ability, duration of class lessons, and whether a science or a social science class is to be tested. Refer to Table 5 and the section entitled Administration Time for guidance.

2 Determine which of the nine TOES scales are to be answered on each of the testing occasions.

Administration on first occasion

3 Instruct students *not* to commence writing until told to do so.

4 Hand out test questions and Answer Sheets.*

5 Clearly tell the class which of the nine TOES scales and which item numbers they are to respond to on this occasion. Write these skill numbers and item numbers clearly on the chalk board.

6 Go through all the Directions on the first page of the test booklets thoroughly with the class. Go over the Practice Question on the chalk board.

7 Emphasize that one answer only should be given to each question, that students must *not* write on the test booklets and that, when altering an answer, the new answer should *not* be written over the top of the old one.

8 Tell students that any extra working can be done on paper provided by either the student or the teacher.

9 Answer any reasonable student queries.

10 Tell each student to write his name, school and class designation legibly on the Answer Sheet, and to commence the test. Encourage students to make their responses legible.

11 During testing, move around the class to check that students are answering questions as instructed. Continue to answer reasonable queries but do not encourage excessive queries.

12 Students who finish early should be given something quiet to do.

13 Collect test booklets when all, or nearly all, pupils have finished. (It is not necessary to allow exceptionally slow students to finish.) Ask students to check that they have written their names on their Answer Sheets.

Administration on second or third occasion

14 Repeat steps 3–5 above. It is particularly important that students are told clearly which skills and which items they are to respond to on this occasion.

15 Briefly go over steps 6–9 above to remind students of the method of answering.

16 Repeat steps 10–13 above.

*The Answer Sheet (Appendix III) may be reproduced without copyright restrictions.

Scoring

17 Each item is scored 1 for the keyed answer listed in Appendix II and 0 for any other (including omitted) answers. Nine separate scale scores can be obtained by adding the scores obtained on all items within a given scale. Although it is not recommended that scores on the nine scales be added to yield a single total score, it would be meaningful to add scores for Skills 1 and 2 to yield a total for Part A (Using Reference Materials), scores for Skills 3–6 to yield a total for Part B (Interpreting and Processing Information) and scores for Skills 7–9 to yield a total for Part C (Critical Thinking in Science).

Recording (optional)

18 For convenience, a table has been provided on the back of the student Answer Sheet so that an individual's score on each TOES scale can be recorded next to the maximum score possible on each scale. A grid has also been provided on the back of the student Answer Sheet for plotting a student's profile of scores on each TOES scale. For comparison purposes, this grid already depicts a profile of mean scores obtained by the samples at the Year 7–10 levels involved in the field testing of TOES.

APPENDIX II

Test Of Enquiry Skills (TOES)

Score Key

Skill 1	
1	C
2	E
3	C
4	D
5	B
6	A
7	A
8	E
9	E
10	B

Skill 2	
11	B
12	D
13	E
14	A
15	B
16	C
17	C
18	D
19	E

Skill 3	
20	C
21	E
22	A
23	E
24	B
25	A
26	D
27	B
28	C
29	B

Skill 4	
30	B
31	C
32	D
33	C
34	E
35	A
36	A
37	E

Skill 5	
38	C
39	C
40	A
41	B
42	A
43	E
44	D
45	D
46	E
47	B
48	E

Skill 6	
49	D
50	B
51	E
52	A
53	D
54	B
55	C
56	E
57	C
58	A

Skill 7	
59	E
60	A
61	D
62	B
63	A
64	D
65	C
66	D
67	A
68	C

Skill 8	
69	B
70	C
71	B
72	E
73	D
74	D
75	A
76	B
77	D
78	A

Skill 9	
79	A
80	B
81	D
82	C
83	C
84	E
85	A
86	B
87	E

APPENDIX III
Test Of Enquiry Skills (TOES)
Answer Sheet

Name _____

School _____ Year/Class _____

Skill 1
Library Usage

Questions 1-3
1 _____
2 _____
3 _____
Questions 4-5
4 _____
5 _____
Questions 6-8
6 _____
7 _____
8 _____
Question 9
9 _____
Question 10
10 _____

Skill 2
Index and Table of Contents

Questions 11-15
11 _____
12 _____
13 _____
14 _____
15 _____
Questions 16-19
16 _____
17 _____
18 _____
19 _____

Skill 3
Scales

Questions 20-29
20 _____
21 _____
22 _____
23 _____
24 _____
25 _____
26 _____
27 _____
28 _____
29 _____

Skill 4
Averages, Percentages, and Proportions

Questions 30-36
30 _____
31 _____
32 _____
33 _____
34 _____
35 _____
36 _____
Question 37
37 _____

Skill 5
Charts and Tables

Questions 38-40
38 _____
39 _____
40 _____
Questions 41-45
41 _____
42 _____
43 _____
44 _____
45 _____
Question 46
46 _____
Questions 47-48
47 _____
48 _____

Skill 6
Graphs

Questions 49-55
49 _____
50 _____
51 _____
52 _____
53 _____
54 _____
55 _____
Question 56
56 _____
Question 57
57 _____
Question 58
58 _____

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Continued over

Test Of Enquiry Skills (TOES)

Answer Sheet

Skill 7
Comprehension of Science Reading

Questions 59-61
59 _____
60 _____
61 _____
Questions 62-64
62 _____
63 _____
64 _____
Question 65
65 _____
Question 66
66 _____
Question 67
67 _____
Question 68
68 _____

Skill 8
Design of Experimental Procedures

Questions 69-78
69 _____
70 _____
71 _____
72 _____
73 _____
74 _____
75 _____
76 _____
77 _____
78 _____

Skill 9
Conclusions and Generalizations

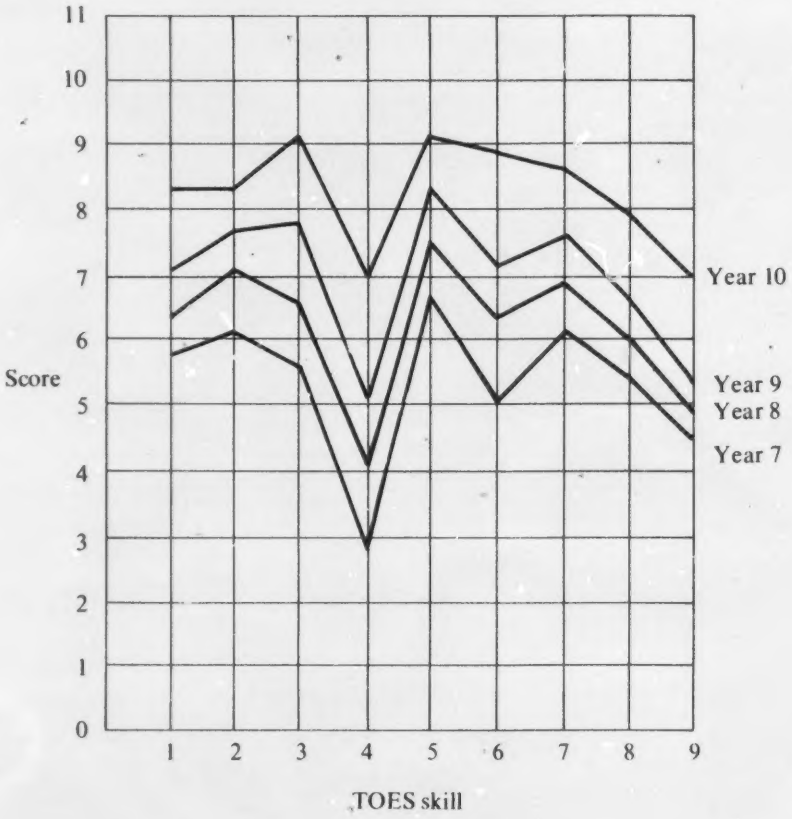
Questions 79-81
79 _____
80 _____
81 _____
Questions 82-84
82 _____
83 _____
84 _____
Question 85
85 _____
Question 86
86 _____
Question 87
87 _____

Scores

Skill	Maximum Score	Actual Score
1	10	
2	9	
3	10	
4	8	
5	11	
6	10	
7	10	
8	10	
9	9	

For teacher use only

Profile



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TEST OF ENQUIRY SKILLS

Barry J. Fraser

Directions

1 The purpose of this test is to find out what things are known by students at school.

2 Try to answer all questions.

3 Do not write on this test booklet. All answers should be written on your Answer Sheet. Any extra working may be done on other paper.

4 Each question has three, four, or five alternative answers represented by the letters **A B C D E**. Choose one answer from the alternatives, and write the letter you have chosen in the space provided on the Answer Sheet.

Practice Question

0 Which one of the following is usually covered with feathers?

A a fish
B a bird
C a dog
D a snake

B is the best answer. Therefore you would write **B** beside **0** on the Answer Sheet, like this:

0 B____

5 If you want to change an answer, cross out your first answer and write the new one beside it.

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Part A
Using Reference Materials

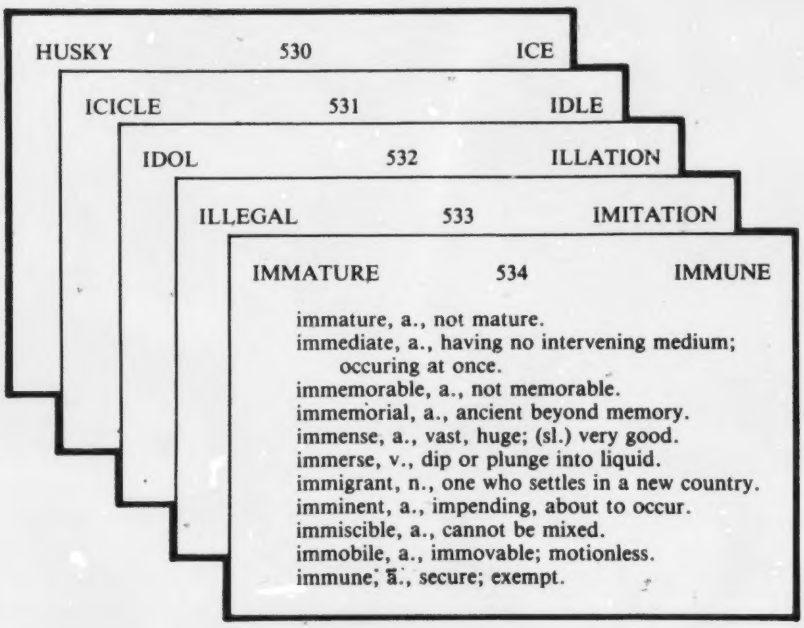
Learning about the lives of tribal people can be very interesting. Part A will test how well you can use reference materials to find out information about different tribes.

Skill 1: Library Usage

In the freezing cold regions of North America, there lives a well-known tribe called the Eskimos. To find information about Eskimos, a library is a useful place to look. Questions **1–10** will test how well you could use a library to find out about Eskimos.

Questions 1-3

To answer Questions **1–3**, use the information in the diagram which shows several pages from a dictionary.


HUSKY 530 ICE
ICICLE 531 IDLE
IDOL 532 ILLATION
ILLEGAL 533 IMITATION
IMMATURE 534 IMMUNE
immature, a., not mature.
immediate, a., having no intervening medium; occuring at once.
immemorable, a., not memorable.
immemorial, a., ancient beyond memory.
immense, a., vast, huge; (sl.) very good.
immerse, v., dip or plunge into liquid.
immigrant, n., one who settles in a new country.
imminent, a., impending, about to occur.
immiscible, a., cannot be mixed.
immobile, a., immovable; motionless.
immune, a., secure; exempt.

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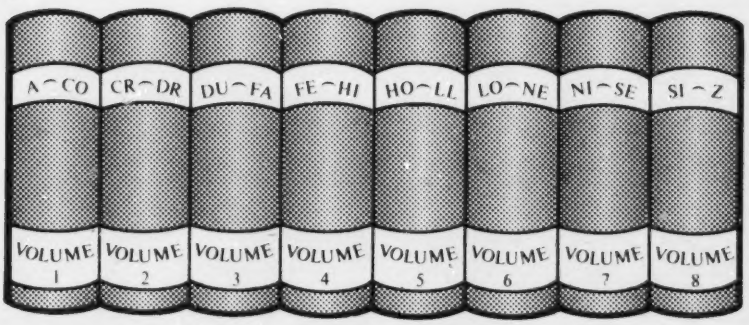
1 On which dictionary page in the diagram would the word 'igloo' be found?
A page 530
B page 531
C page 532
D page 533
E neither **A**, nor **B**, nor **C**, nor **D**

2 Only one of the following ways of spelling a word is correct.
According to the diagram, the correct spelling is
A immence. C imence. E immense.
B emmense. D imense.

3 The dictionary pages in the diagram show that 'imminent' means
A famous.
B not mature.
C about to happen.
D a person in a new country.
E very large.

Questions 4–5

Below is a diagram showing a set of volumes of an encyclopaedia. Use the information to answer Questions **4–5**.



4 For food, the Eskimos often catch salmon that have become trapped in the waters beneath the ice.
In which volume of the encyclopaedia would it be best to look first to find as much information as possible about salmon?
A Volume 1 C Volume 5 E Volume 8
B Volume 3 D Volume 7

5 In which one of the volumes would it be best to look first for a picture of the following: a salmon, a whiting and a sardine?
A Volume 3 C Volume 5 E Volume 8
B Volume 4 D Volume 7

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Questions 6–8

Below is a list of five references found at the back of a book on Eskimos. Use these references to answer Questions **6–8**.

REFERENCES

1 Bandi, Mary. *Eskimo History*. London: Methuen, 1969.
2 Carpenter, Ann S. Eskimos, *The Tribal Studies Journal*, 15, 1970, 37–45.
3 Henry, Norman. *The Eskimo of North Alaska*. Washington: John Wiley, 1966.
4 Honigmann, John M. *Eskimo Townsmen*. New York: Prentice-Hall, 1965.
5 Wright, James W. *Eskimos of the Nushagak River*. Melbourne: Macmillan, 1967.

6 In which one of the references would it be best to look first to find information about Eskimos in the eighteenth century?

A reference 1 **C** reference 3 **E** reference 5
B reference 2 **D** reference 4

7 The name of the author of *The Eskimo of North Alaska* is

A Norman Henry. **C** Washington. **E** John Wiley.
B Henry Norman. **D** Wiley John.

8 In which part of the book *Eskimo History* would it be best to look for an alphabetical (a b c) list of the topics contained in that book?

A Introduction **C** Table of contents **E** Index
B Preface **D** Appendix

Question 9

One of the references on Eskimos was:

5 Wright, James W. *Eskimos of the Nushagak River*. Melbourne: Macmillan, 1967.

In order to find this book in a library, a library catalogue could be used. The diagram below shows the letters that appear on the front of the drawers of a library catalogue.

AUTHORS AND TITLES			SUBJECTS	
Aa-Be	Gu-Ku	Pr-Re	A-D	M-P
Bi-Ep	La-Mu	Ri-Um	E-G	Q-S
Eq-Gr	Na-Po	Un-Zy	H-L	T-Z

9 The easiest way to find reference 5 in the library catalogue would be to look in the drawer marked

A Gu-Ku. **C** La-Mu. **E** Un-Zy.
B E-G. **D** T-Z.

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Question 10

The library catalogue card for reference 5 is shown in Figure 1.

WRIGHT, James W. 971.46
W969E

Eskimos of the Nushagak River

Melbourne, Macmillan, (1967)

1. Eskimos – United States – Alaska
2. Nushagak River – Alaska
3. Arctic America – Eskimo

Figure 1

The part of the library shelf that would contain the above book is shown in Figure 2.

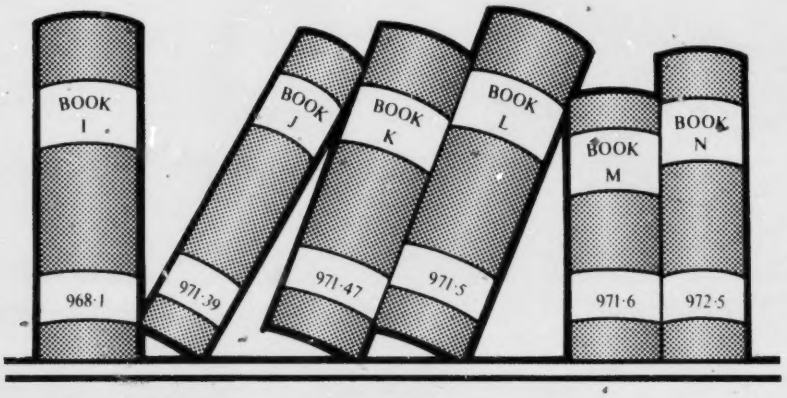

Figure 2

10 On the library shelf shown in Figure 2, the book called *Eskimos of the Nushagak River* belongs

A between Book I and Book J.
B between Book J and Book K.
C between Book K and Book L.
D between Book L and Book M.
E between Book M and Book N.

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Skill 2: Index and Table of Contents

Not all tribal people live in as cold a climate as the Eskimos do. Two tribes living in a much warmer climate are the Australian aborigine and the New Guinea native. Questions **11–20** will test how well you could use the Index and Table of Contents in books to find out about these two tribes.

Questions 11–15

To answer Questions **11–15**, use the Table of Contents on page 8, which is taken from a book about Australian aborigines.

11 On which one of the following pages would information about the arrival of the white man be found?

A page 6
B page 14
C page 39
D page 80
E page 85

12 In which chapter would information about how boomerangs are made be found?

A Chapter 2
B Chapter 3
C Chapter 5
D Chapter 6
E Chapter 7

13 Information about Evonne Cawley (the well-known tennis player) would be found in

A Chapter 1.
B Chapter 3.
C Chapter 4.
D Chapter 6.
E Chapter 7.

14 In Chapter 5, information would be found about

A the magic of the medicine man.
B the language spoken by aborigines.
C bark paintings.
D places where aborigines live.
E animals hunted by the aborigines.

15 The Table of Contents on page 8 shows a list of the topics covered in this book about aborigines. Which one of the following titles for the book tells most about what the book contains?

A *Life in Australia Before 1770*
B *The Aboriginal Way of Life*
C *The Coming of the White Man*
D *Aboriginal Craftsmanship*
E *The Australian Aborigine Today*

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TABLE OF CONTENTS

Chapter		Page
1	ARRIVAL OF THE ABORIGINES	5
	The Journey to Australia	5
	Early Tribal Areas	8
	Adapting to the Environment	9
2	ARRIVAL OF THE WHITE MAN	11
	Treatment of Aborigines by White Man	11
	Reaction of Aborigines to White Man	15
3	DISTINGUISHING BETWEEN TRIBES	17
	Areas of Settlement	18
	Language	20
	Hunting Grounds	21
	Differences in Laws	22
4	UNDERSTANDING ABORIGINAL ATTITUDES	25
	Class Structure	26
	Marriage	31
	Illness	34
	Death	39
5	ABORIGINAL CUSTOMS	45
	Initiation Ceremonies	45
	Corroborees	49
	Walkabouts	52
	Religion	56
6	ABORIGINAL CRAFTSMANSHIP	58
	Paintings	59
	Making Tools for Food Gathering	66
	Aboriginal Musical Instruments	69
7	ABORIGINES TODAY	79
	How and Where They Live Today	80
	Famous Aborigines	83
	Attitudes of the Government	85
INDEX		93

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Questions 16-19

To answer Questions **16-19**, use the Index below which has been taken from the back of a book about New Guinea natives.

INDEX

Agriculture, 56–69; ceremonial feast after harvest, 68; crop planting, 57; harvesting, 65; methods of sowing, 58; protection from wild animals, 60; types of crops, 56; weeding, 59; work of men in, 57, 63

Animals, domestic 53-54; used in agriculture, 56; wild, 54

Bead-making, *see* Craftsmanship

Busama tribe, hunting practices, 7; *see aiso* Tribes of the New Guinea Highlands

Burial, *see* Death

Children, birth of, 35; raising of, 36; *see also* Marriage, Initiation

Craftsmanship, 16–21; bead-making, 16; farming tools, 19; making of weapons, 21; pottery, 17

Crops, *see* Agriculture

Death, burial ceremony, 40; customs of the widow, 40; rituals surrounding, 37; taboos, 38–39

Dress, 11–15; beads, 14; ornaments, 13; tribal, 11

Farming, tools, 19; *see also* Agriculture

Houses, construction of, 8; family, 9; size of, 8

Initiation, ceremonies, 22–26; entrance to adulthood, 23; taboos, 24

Intermarriage, *see* Marriage

Kapauku tribe, *see* Tribes of the New Guinea Highlands

Kuma Tribes, *see* Tribes of the New Guinea Highlands

Kunimaipa tribe, *see* Tribes of the New Guinea Highlands

Mae Enga tribe, *see* Tribes of the New Guinea Highlands

Marriage, ceremony, 28; children, 29; customs, 30; inter-marriage, 34; preparation for, 27

New Guinea, 6, 13, 57

Port Moresby, 6

Religious practices, 41–52

Taboos, *see* Death, Initiation

Tribal hunting grounds, 7

Tribes of the New Guinea Highlands, 5

Weapon making, *see* Craftsmanship

16 For information about the Kuma tribe living in the mountains of New Guinea, you would look in the Index under

A Tribal hunting grounds.
B Craftsmanship.
C Tribes of the New Guinea Highlands.
D New Guinea.
E Port Moresby.

17 To find information about New Guinea children you would first look in the Index under the heading

A New Guinea.
B Marriage.
C Children.
D Tribes of the New Guinea Highlands.
E Busama Tribe.

18 Where would you turn to find information about burial ceremonies?

A page 14 **C** page 37 **E** page 68
B page 22 **D** page 40

19 The tribal dress worn by tribesmen would be described on

A page 37. **C** page 16. **E** page 11.
B page 22. **D** page 12.

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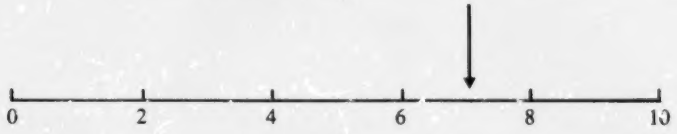
Part B
Interpreting and Processing Information

Skill 3: Scales

Questions 20-29

20 The diagram below represents some of the distance posts along a country road.



A motorist runs out of petrol at the point marked by the arrow.
If there was a distance post at this point, it would show a reading of

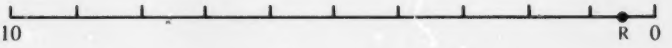
A 6 .
B 6½ .
C 7 .
D 7½ .
E 8 .

21

In the above scale, the reading at point P is

A 30 .
B 25 .
C 2 .
D 10 .
E 20 .

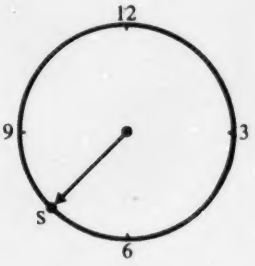
22



In the above scale, the reading at point R is

A ½ .
B 1 .
C 8½ .
D 9 .
E 9½ .

23



On the dial shown in the diagram, the reading at point S is

A 2.5 .
B 6.0 .
C 6.5 .
D 7.0 .
E 7.5 .

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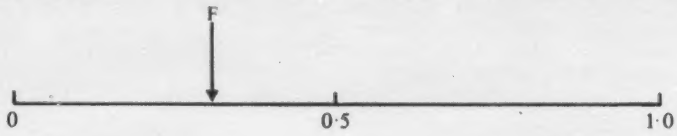
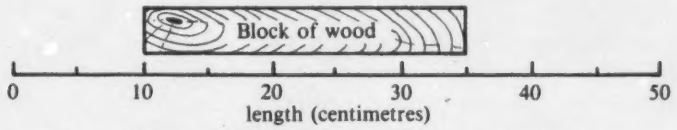
24 In a jumping competition a frog landed at the point marked by the arrow F in the diagram below.



The reading at F is

A 0.25 .
B 0.30 .
C 0.40 .
D 0.45 .
E 0.70 .

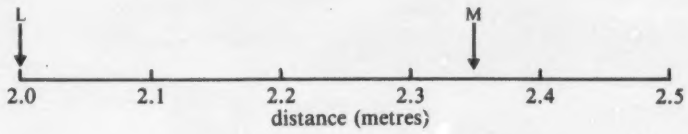
25



The length of the block of wood shown in the above diagram is

A 25 centimetres.
B 20 centimetres.
C 15 centimetres.
D 30 centimetres.
E 35 centimetres.

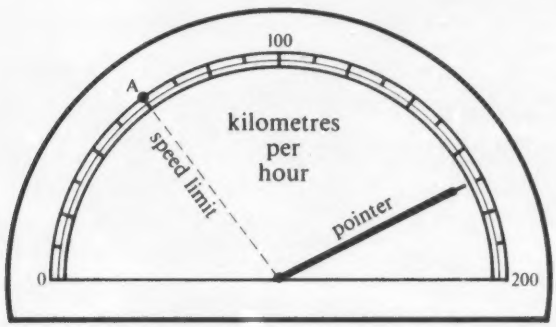
26 A beetle started crawling at L and crawled to M, as shown in the diagram.



The beetle crawled

A 2.40 metres.
B 2.35 metres.
C 0.40 metres.
D 0.35 metres.
E 0.30 metres.

27 The diagram below shows a car speedometer. The speed limit is shown at point A.



When the speedometer pointer is in the position shown, the car is exceeding the speed limit by

A 60 kilometres per hour.
B 110 kilometres per hour.
C 140 kilometres per hour.
D 165 kilometres per hour.
E 170 kilometres per hour.

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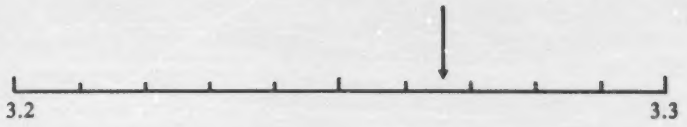
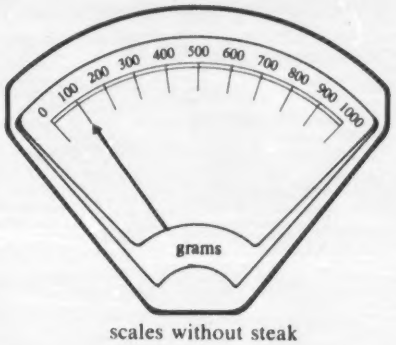
28



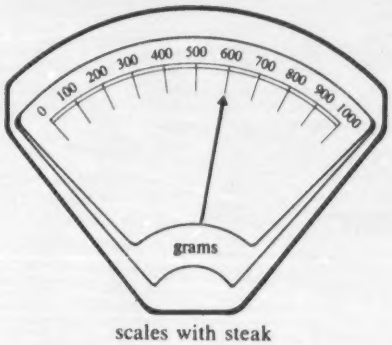
In the above diagram, the arrow is pointing to

A 3.234 .
B 3.260 .
C 3.266 .
D 3.274 .
E 3.860 .

29 Mrs Hughes used her kitchen scales to find out the weight of some steak.



scales without steak



scales with steak

According to the readings in the two diagrams, Mrs Hughes's steak weighs

A 100 grams.
B 500 grams.
C 600 grams.
D 700 grams.

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Skill 4: Averages, Percentages and Proportions

Questions 30–36

To answer Questions **30–36**, use the following information.
In a football match the winning team kicked a total of 20 goals. The names of the four goal-kickers together with the number of goals kicked by each person are shown below.

Name of goal-kicker	*Number of goals kicked*
Jim	10
Bill	5
Alex	3
Jack	2
	20

30 The average (mean) number of goals kicked by Jim, Bill, Alex, and Jack was
A 2 . **C** 6 . **E** 20 .
B 5 . **D** 10 .

31 The average (mean) number of goals kicked by Bill and Alex was
A 2 . **C** 4 . **E** 10 .
B 2½ . **D** 8 .

32 The average (mean) number of goals kicked by Jim, Bill, and Jack was
A 17 . **C** 6⅔ . **E** 3⅓ .
B 8½ . **D** 5⅓ .

33 The proportion of the total score kicked by Jim was
A 10.0 . **C** 0.5 . **E** 0.1 .
B 2.0 . **D** 0.2 .

34 Which pair of players together kicked ¾ of the total score?
A Alex and Jack **C** Jim and Jack **E** Jim and Bill
B Jack and Bill **D** Bill and Alex

35 The percentage of the total score kicked by Bill was
A 25 per cent. **C** ¼ per cent. **E** 20 per cent.
B 50 per cent. **D** 5 per cent.

36 The player who kicked 15 per cent of the total score was
A Alex.
B Bill.
C Jack.
D Jim.
E neither **A**, nor **B**, nor **C**, nor **D**.

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Question 37

37 Suicide insect-spray takes different amounts of time to kill different types of insects. The figures below show the times taken to kill various insects which were sprayed with equal amounts of Suicide insect-spray.

Type of insect	*Time taken to kill insect*
Fly	2.5 seconds
Beetle	3.6 seconds
Ant	3.6 seconds
Silverfish	3.8 seconds
Cockroach	4.0 seconds
Moth	4.7 seconds

The average (mean) time in which Suicide insect-spray killed the above insects was

A 22.2 seconds.
B 11.1 seconds.
C 2.5 seconds.
D 3.6 seconds.
E 3.7 seconds.

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Skill 5: Charts and Tables

Questions 38–40

At Bunyip High School there are 36 students in Year 12A. These students either walk to school or travel by train, car, bus or cycle. The following diagram shows the number of students using each of these methods of travel. Use the diagram to answer Questions **38–40**.

38 The two methods of travel which are used by approximately the same number of students are

A train and walk.
B bus and train.
C cycle and train.
D walk and cycle.
E bus and car.

39 The number of students who walk to school is equal to the combined number who use

A car and cycle.
B cycle and train.
C train and bus.
D bus and car.
E train, car, and bus.

40 Which one of the following statements is supported by the information in the diagram?

A No student in Year 12A uses trams to come to school.
B Some students cycle some days but walk on other days.
C The students coming by car have their own licences.
D The students who come by train also come by bus.
E There are few buses that pass the school.

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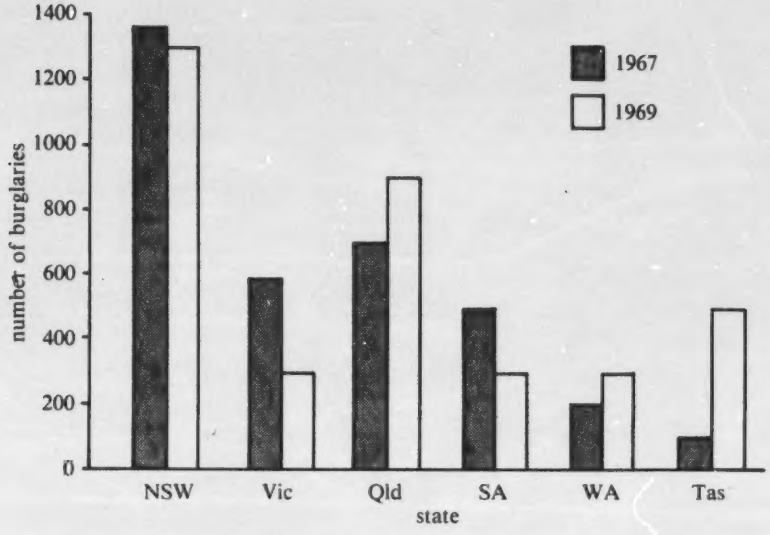
Questions 41–45

The figure below shows the number of burglaries in various Australian States during 1967 and 1969. Use the figure to answer Questions **41–45**.



Crime in Australia: Statistics for House Burglaries for Years 1967 and 1969.

41 Which one of the following States had 500 burglaries in 1967?

A Tasmania
B South Australia
C Victoria
D Western Australia
E Queensland

42 The difference between the number of burglaries in Tasmania in 1967 and 1969 was

A 400 .
B 450 .
C 500 .
D 550 .
E 600 .

43 Which one of the following States had the smallest change in the number of burglaries between 1967 and 1969?

A Queensland
B Western Australia
C South Australia
D Victoria
E New South Wales

44 In which one of the following pairs of States did each State have more burglaries in 1967 than in 1969?

A New South Wales and Queensland
B South Australia and Western Australia
C Queensland and Victoria
D New South Wales and Victoria
E South Australia and Tasmania

45 The number of burglaries in Queensland in 1967 was greater than the number in Victoria in 1969 by

A 100 .
B 200 .
C 300 .
D 400 .
E 600 .

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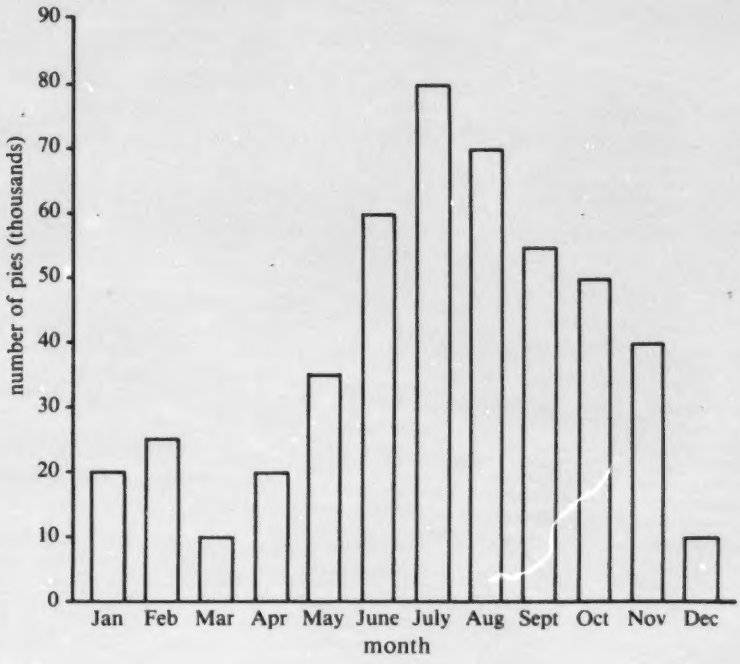
Question 46

The diagram below shows the number of pies sold in a local city during different months of last year.



46 The pie sales for February and August combined are equal to the combined sales in

A October and November.
B July and December.
C June and November.
D September and May.
E May and June.

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Questions 47–48

The figure below shows the rainfall for six Australian cities during a period of seven months. Use this figure to answer Questions **47–48**.

Rainfall (centimetres)

City	Month							
	Jan.	Feb.	Mar.	April	May	June	July	Total
Bourke	3.5	4.0	3.0	2.8	2.5	3.0	2.3	21.1
Darwin	40.5	31.0	28.0	7.8	0.8	0.3	0.0	108.4
Perth	0.8	1.3	2.3	4.5	12.8	19.0	17.8	58.5
Sydney	9.8	8.0	11.0	14.3	12.5	9.3	12.3	77.2
Alice Springs	4.3	3.3	2.8	1.0	1.5	1.3	0.8	15.0
Hobart	4.5	4.8	5.3	5.8	4.3	5.8	5.8	36.3

47 Which one of the following cities has the same rainfall in three different months?

A Alice Springs **C** Sydney **E** Perth
B Hobart **D** Bourke

48 During the whole seven-month period, which one of the following cities had the second highest total rainfall?

A Hobart **C** Darwin **E** Sydney
B Perth **D** Bourke

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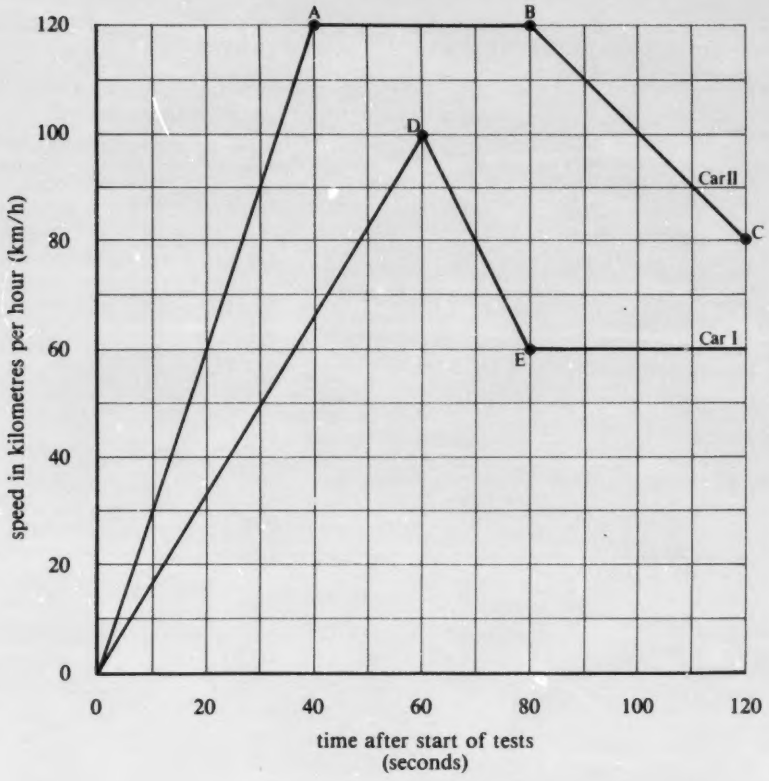
Skill 6: Graphs

Questions 49–55

The graph below has been drawn from information obtained during a series of car tests. It shows the speeds of two cars at different times. Use this graph to answer Questions **49–55**.



49 Which point on the graph indicates the speed of Car I after 60 seconds?

A Point A **C** Point C **E** Point E
B Point B **D** Point D

50 The point which represents a speed of 120 km/h after 80 seconds is

A Point A. **C** Point C. **E** Point E.
B Point B. **D** Point D.

51 In the time interval 40 seconds–80 seconds, the speed of Car II

A was zero.
B increased.
C decreased.
D increased then decreased.
E stayed the same.

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52 After 60 seconds, the speed of Car II
- **A** was greater than the speed of Car I.
- **B** was less than the speed of Car I.
- **C** was equal to the speed of Car I.
- **D** cannot be obtained from the information in the graph.

53 The time taken by Car II to reach 60 km/h is
- **A** 140 seconds.
- **B** 40 seconds.
- **C** 5 seconds.
- **D** 20 seconds.
- **E** not obtainable from information in the graph.

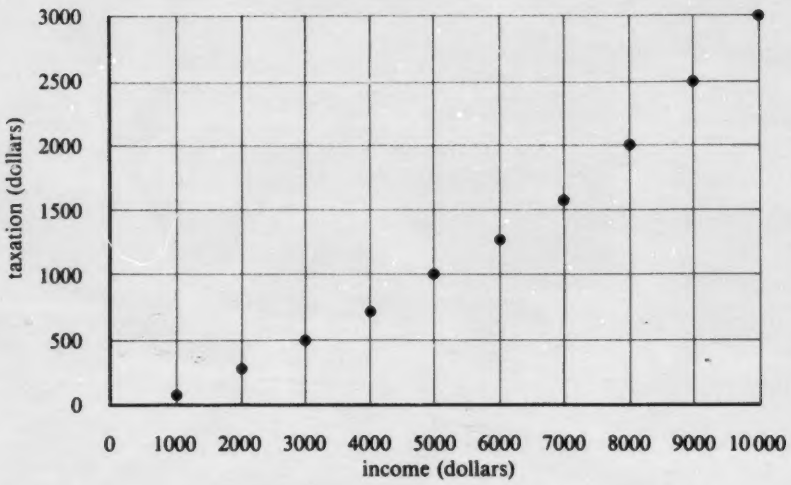
54 The graph shows that the time taken by Car II to reach 60 km/h
- **A** is greater than the time taken by Car I.
- **B** is less than the time taken by Car I.
- **C** is equal to the time taken by Car I.

55 The time taken by Car I to decrease its speed from 100 km/h to 60 km/h is

A 2 seconds. **C** 20 seconds. **E** 80 seconds.
B 10 seconds. **D** 40 seconds.

Question 56

The graph below shows the relationship between income and taxation.



56 A person who pays a tax of $1000 has an income of

A $0 . **C** $1000 . **E** $5000 .
B $100 . **D** $4000 .

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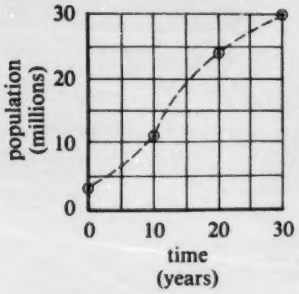
Question 57

The population of a particular country changed rapidly in the years 1900 to 1930. The following table shows how the population changed from 3 million to 24 million over this period of 30 years.

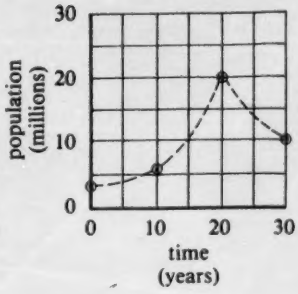
Time (years)	0	10	20	30
Population (millions)	3	6	12	24

Compare each of Graphs A–E shown below with the above table. Only one graph is the correct picture of the table.

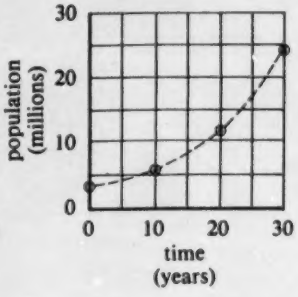
Graph A



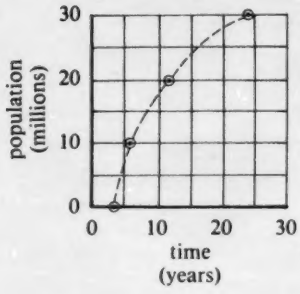
Graph B



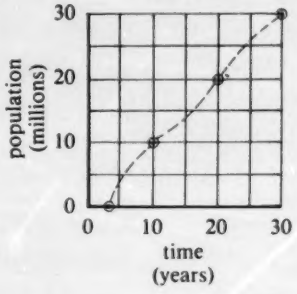
Graph C



Graph D



Graph E



57 Which one of these graphs correctly represents the information in the table?

A Graph A
B Graph B
C Graph C
D Graph D
E Graph E

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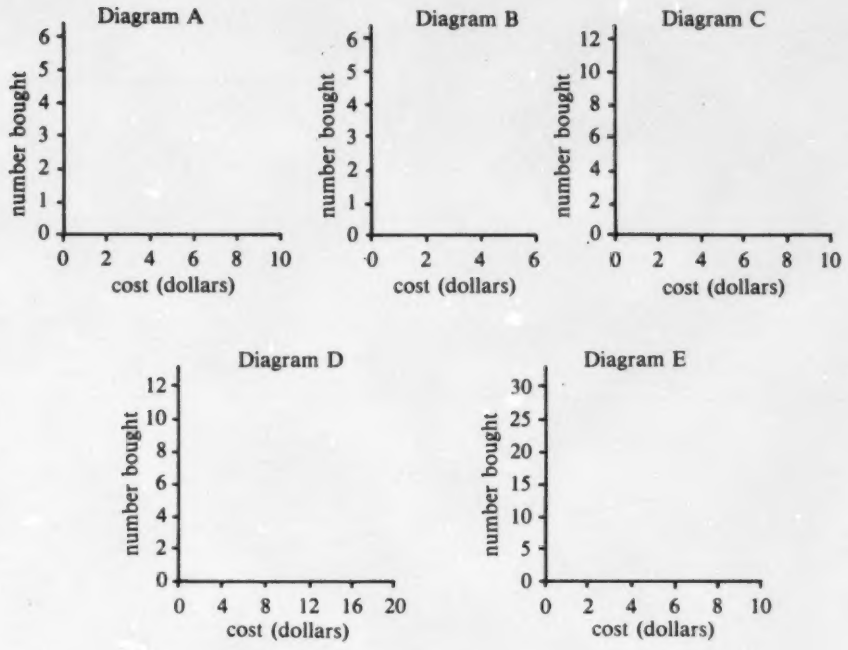
Question 58

A teenager was asked how many pairs of jeans he would buy at different prices. The following information was obtained:

cost (dollars)	3	4	5	6	7	8	9
number of pairs bought	6	6	5	4	3	3	2

Below are five ways of drawing the scales for the graph of this table.



58 Which diagram shows the best scales to use in drawing a graph for the table?

A Diagram A
B Diagram B
C Diagram C
D Diagram D
E Diagram E

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Part C
Critical Thinking in Science

Skill 7: Comprehension of Science Reading

The purpose of this test is to see how well you can understand what you read. Read the information given, and use *only* this information to answer Questions **59–68**.

Questions 59–61

Use paragraphs *1–8* to answer Questions **59–61**.

1 Christian Eijkman, a Dutch Army Doctor, was a member of a medical team sent to study the disease beriberi in the people of the Dutch East Indies. During the 1890s this dreaded disease killed millions of people every year.

2 When Eijkman was visiting a native prison on the island of Java, he noticed that the chickens in the prison yard were showing signs of the disease.

3 Like the prisoners, the chickens held their heads at an unnatural angle and walked in a strange manner. Yet chickens outside the prison were healthy.

4 Chickens outside the prison ate a variety of foods while the chickens inside ate only polished rice left over from the prisoners' meals.

5 Eijkman suggested the disease might be a matter of diet.

6 Starting with healthy chickens, Eijkman divided them into two groups. Group 1 was fed whole rice grain, and Group 2 was fed polished rice, that is, rice without the brown skin.

7 Chickens in Group 1 remained healthy, while those in Group 2 developed the disease.

8 Eijkman decided that the brown skin of the rice contained something which prevented the disease beriberi. (It was Vitamin B.)

59 Christian Eijkman was sent to the Dutch East Indies especially to
- **A** study the prisoners.
- **B** grow rice for the prisoners.
- **C** find a method of polishing rice.
- **D** cure diseases in chickens.
- **E** study the disease beriberi.

60 The disease beriberi is found in
- **A** chickens and humans.
- **B** humans only.
- **C** chickens only.
- **D** rice only.
- **E** rice and chickens.

61 Part of a theory to explain the doctor's observations is presented in
- **A** paragraph *1*.
- **B** paragraph *2*.
- **C** paragraph *3*.
- **D** paragraph *5*.
- **E** paragraph *6*.

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Questions 62–64

Use paragraphs *1–7* to answer Questions **62–64**.

1 Did you know that many bird songs are not for the enjoyment of man but a means of telling other birds to stay away? Before selecting a female for a mate the male bird stakes out a territory. He does this by fighting with, and chasing out, other birds from the chosen area.

2 After a mate is selected a nest is built by the pair of birds and eggs are laid by the female. Usually it is the mother bird that keeps the eggs warm. She sits on the nest for many days while the eggs are incubating.

3 During the first few weeks after the young birds hatch they eat a huge amount of food. The poor parent birds are kept so busy flying long distances to collect suitable food that they get very thin.

4 The young bird which hatches first gets most of the food, grows faster and may even push other young birds out of the nest.

5 While on the ground the fledglings are quickly eaten by enemies such as owls and cats.

6 Some parent birds overcome the food problem by collecting and storing food for a few days before the eggs are due to hatch.

7 One such bird is the crested bellbird. These birds collect caterpillars, cripple them and place them on the branches of a tree near the nest.

62 Parent birds can become very thin if they

A spend a lot of time singing.
B search for food most of the time.
C get pushed out of the nest.
D eat crippled caterpillars.
E sleep on the ground.

63 The way a bird claims its living area is described in

A paragraph *1*.
B paragraph *2*.
C paragraph *4*.
D paragraph *5*.
E paragraph *6*.

64 Parent bellbirds place a lot of crippled caterpillars on branches near the nest to

A decorate the tree.
B attract other caterpillars to the tree.
C frighten away other birds.
D have a large amount of food in reserve.
E supply food for fledglings that have fallen out of the nest.

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Question 65

Ninety-two different chemical elements can be found in the earth. The following table provides information about some of these elements.

Name of element	Appearance when pure	Common way the element occurs
Aluminium	light grey shiny metal	combined with oxygen in clay
Carbon	shiny black solid	by itself as coal
Oxygen	colourless gas	by itself in air or combined with hydrogen in water
Chlorine	greenish yellow gas	combined with sodium in table salt
Platinum	heavy white metal	by itself
Silicon	brown powder	combined with oxygen in clay
Iodine	bluish grey solid	by itself as particles in sea-water
Nitrogen	colourless	by itself in air

65 The element silicon could be obtained from

A the air.
B a packet of kitchen salt.
C clay in the garden.
D rain-water.
E sea-water.

Question 66

Banana growers want to earn as much money as possible. To do this they have to sell more fruit.

There are problems involved in the transport of bananas from Queensland to Melbourne.

Sometimes the fruit becomes dried out during its journey south. Partly lining the boxes with wax paper prevents this happening.

During the train trip they are shaken continuously and may become too soft and ripe to eat when they arrive in Melbourne. To prevent this happening they are picked from the tree when they are hard and green.

However fruit shops in Melbourne cannot sell hard green bananas. To overcome this problem the bananas are stored in rooms filled with nitrous oxide (laughing gas). This is done for a day before they go to the shops. It ripens them. Therefore the customers can buy light yellow, firm, juicy fruit.

66 Banana boxes are partly lined with wax paper to

A help ripen the bananas quickly.
B keep the nitrous oxide gas inside the box.
C prevent fruit flies getting into the box.
D keep the moisture in the fruit.

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Question 67

Friction is a force that can act between two objects when one is moving across the surface of the other.

In an experiment, several flat blocks of the same metal are allowed to slide down a wooden plank. For this experiment, the amount of friction increases with the weight of the moving block but not with the area of contact between the block and the plank.

The following table shows the weight of these blocks together with the area of the surface of each block touching the plank.

Block	Weight of block (Newtons)	Area of contact with plank (square centimetres)
A	5	300
B	3	400
C	1	350
D	4	500
E	2	450

67 The greatest amount of friction will occur between the plank and

A Block A. **C** Block C. **E** Block E.
B Block B. **D** Block D.

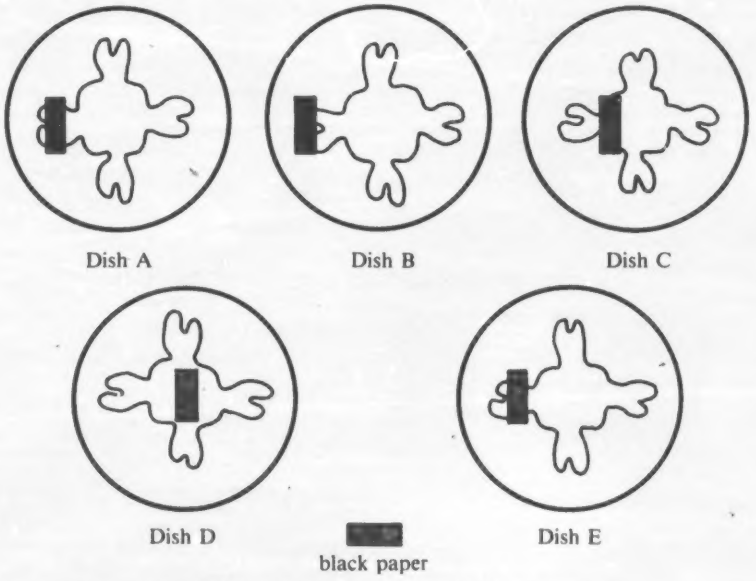
Question 68

There is a small jellyfish which crawls around the bottom of ponds. It has a central body with four radiating branched arms.

There are four light receptors, one at the junction where each arm joins the body.

One branch of each arm ends in a suction pad and the other branch ends in a disc covered with stinging cells.

During the experiment, a jellyfish is placed in each of the five dishes shown below. Parts of each of these jellyfish are covered with black paper as shown.



68 A light receptor of the jellyfish is covered with black paper in

A Dish A. **C** Dish C. **E** Dish E.
B Dish B. **D** Dish D.

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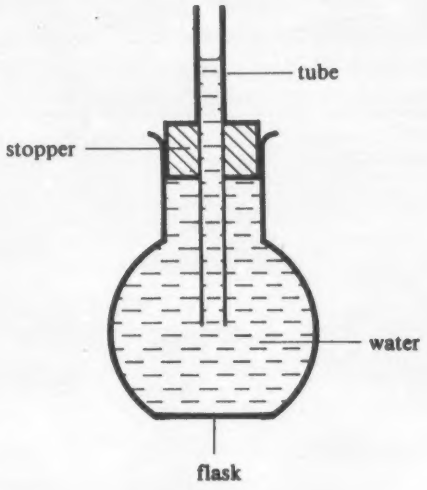
Skill 8: Design of Experimental Procedures

Questions 69–78

69 When Harry was at the beach, he wondered if sound could travel through water. To test this idea, Harry decided to hit two stones together.
Which one of the following is **not** a suitable method for testing if sound can travel through water?

A Hit two stones together in the water with the ears in the air.
B Hit two stones together in the air with the ears in the air.
C Hit two stones together in the water with the ears in the water.
D Hit two stones together in the air with the ears in the water.

70 The flask was set up to show that heat causes water to expand. The water level in the tube was marked, and then the flask was gently heated. After initial heating, the water level rose. The change in water level was noted.



For the success of the above experiment, which of the following is the most important?

A size of the flask
B shape of the flask
C fit of the stopper
D length of the tube

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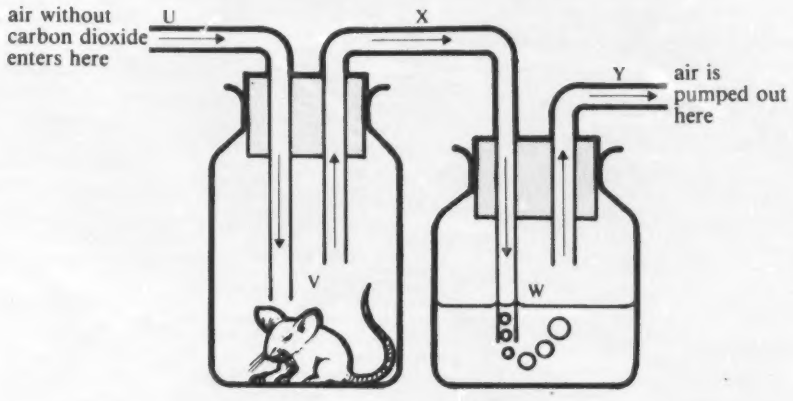
Question 71

The experimental apparatus in the diagram can be used to show that mice give out carbon dioxide gas when they breathe.

U is a tube carrying air with its carbon dioxide removed. V is a glass container in which a mouse is placed for a short time. X is a tube joining V and W. W is a container with a special liquid that changes colour when carbon dioxide is passed through it. Y is a tube to remove the air from W.



71 The above experiment would give results quickest if the container V was
- **A** large.
- **B** small.
- **C** kept cool.
- **D** placed in the dark.
- **E** placed in a bright light.

72 Mary and Jane each bought the same kind of rubber ball. Mary said: 'My ball bounces higher than yours.' Jane replied: 'I'd like to see you prove that.'

Mary should
- **A** throw both balls against a wall and see how far each ball bounces off the wall.
- **B** drop the two balls from different heights and notice which bounces higher.
- **C** throw the balls down against the floor and see how high they bounce.
- **D** feel the balls by hand to find which is the harder.
- **E** drop both balls from the same height and notice which bounces higher.

73 Dr R. Choo believes that he has developed a vaccine that will prevent mumps.
At his hospital Dr Choo has 30 people who are willing to test the vaccine. He decides to give the vaccine to 15 of these people.

In order to test if the vaccine works, Dr Choo should expose to the mumps disease
- **A** none of the 30 people.
- **B** only the 15 people who received the vaccine.
- **C** only the 15 people who did not receive the vaccine.
- **D** all of the 30 people.

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74 Lying on the bench was a box containing an assortment of metal and non-metal rods. Tom's teacher asked him to find out whether the metal rods were better heat conductors than the non-metal rods.

Tom chose a steel rod and held the tip of the rod in the flame of a bunsen burner. After a short time, the rod was too hot to hold.

Before Tom could tell his teacher that he believed that all metal rods were better heat conductors than non-metal rods, he should

A heat another steel rod.
B heat all the metal rods but none of the non-metal rods.
C heat all the non-metal rods but none of the metal rods.
D heat all the metal and all the non-metal rods.

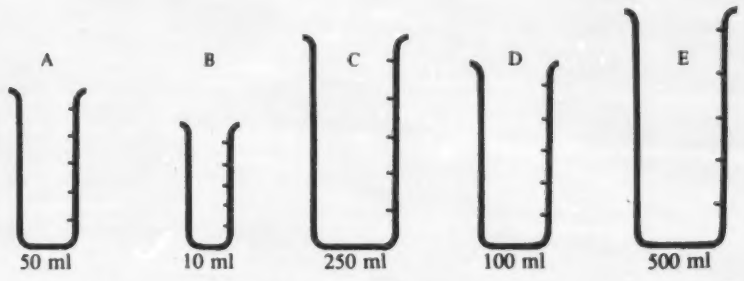
75 Mary wanted to find out if something in the air caused boiled milk to go sour. To investigate this, she carried out the following steps:

She boiled a container filled with milk.
She left the boiled milk without a lid for 10 minutes.
She then put the lid on the container of boiled milk.
She left the container untouched in a cupboard for a week.
After a week she observed that the milk had gone sour.

In order to conclude that something in the air had caused the milk to go sour, Mary would also need

A a container of boiled milk that had its lid put on as soon as the milk boiled.
B a container of unboiled milk with its lid on.
C a container of boiled milk that was left without its lid for the whole week.
D an empty container with its lid off.
E a container of milk that was already sour with its lid on.

76 Below are five containers which can be used for measuring amounts of liquid.



Which of the above containers would be the most accurate to use to measure five millilitres of water?

A container A
B container B
C container C
D container D
E container E

77 A can of paint contains enough paint to cover 100 square metres (10 metres long and 10 metres wide).

To decide how many cans of paint are needed to paint the inside of a school classroom, measurements are taken to the nearest

A millimetre.
B centimetre.
C 10 centimetres.
D metre.
E 10 metres.

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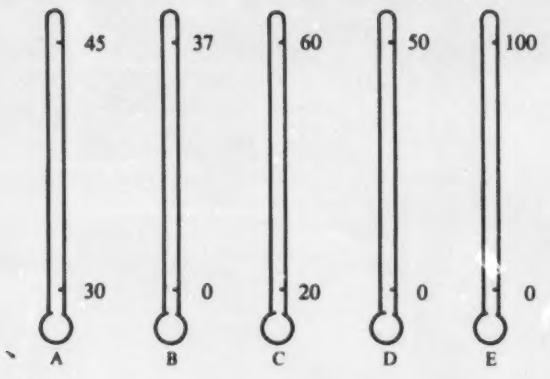
78 The diagram shows five different mercury-in-glass Celsius thermometers.



The normal human body temperature is 37 degrees Celsius. The body temperature of sick people ranges from about 36 to 42 degrees Celsius.

The thermometer most suited for accurately measuring body temperature would be

A thermometer A.
B thermometer B.
C thermometer C.
D thermometer D.
E thermometer E.

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Skill 9: Conclusions and Generalizations

Questions 79–81

Imagine that a space crew makes a trip to a far distant world called Zania. The crew members make statements about the Zanians. In Questions **79–81**, work out what follows from each crew member's statement.

79 The pilot says: 'Only Zanians have twelve fingers. The people coming towards us have twelve fingers.'
Which one of the statements **A–C** follows from what the pilot said?
A 'The people coming towards us must be Zanians.'
B 'The people coming towards us could not be Zanians.'
C 'We don't know whether the people coming towards us are Zanians or not.'

80 The doctor says: 'All Zanians have three legs. Those people over there have two legs.'
Which one of the statements **A–C** follows from what the doctor said?
A 'Those people must be Zanians.'
B 'Those people could not be Zanians.'
C 'We don't know whether those people are Zanians or not.'

81 A scientist says: 'Only blue-eyed Zanians can become blind. All blue-eyed Zanians are male.'
Which one of the statements **A–E** follows from what the scientist said?
A All male Zanians are blind.
B No male Zanian is blind.
C Some female Zanians are blue-eyed.
D No female Zanian is blind.
E All female Zanians are blind.

Questions 82–84

Konrad Lorenz was very interested in Mallard ducklings (baby ducks). In particular, he liked to watch the way ducklings follow the mother duck around. To explain this he had the following idea:

Idea The quacking of the mother duck is what attracts Mallard ducklings to her.

To see if his idea was right, Konrad Lorenz made the six observations listed below. Some of these observations suggest that Konrad Lorenz's *Idea* is true and others suggest that it is false. Some observations tell us nothing about whether the idea is true or false. Use these observations to answer Questions **82–84**.

Observation I A white farmyard duck quacked like a Mallard duck and was followed by the Mallard ducklings.

Observation II The ducklings did **not** follow a toy duck which looked like a Mallard duck.

Observation III A duck, which could **not** quack, hatched some Mallard eggs and the ducklings followed her.

Observation IV Konrad Lorenz made a noise like a Mallard duck and the ducklings followed him.

Observation V Konrad Lorenz made a noise like a rooster and the ducklings followed him.

Observation VI A dog barked at the ducklings and they ran away.

82 Which one of the following provides information that suggests that Konrad Lorenz's *Idea* is true?
A Observation II
B Observation III
C Observation IV
D Observation V
E Observation VI

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83 Which one of the following observations provides evidence that Konrad Lorenz's *Idea* is **false**?

A Observation I
B Observation II
C Observation III
D Observation IV
E Observation VI

84 Which one of the following observations provides **no information** that helps to decide whether Konrad Lorenz's *Idea* is true or false?

A Observation I
B Observation III
C Observation IV
D Observation V
E Observation VI

Question 85

Harry wanted to know whether white bread, rye bread or whole-wheat bread was best for the growth of young guinea pigs. To test this, Harry obtained 30 young guinea pigs, all of the same weight. He put each guinea pig in a separate cage and fed them in the following way:

10 guinea pigs were given 250 grams of white bread daily;
10 guinea pigs were given 250 grams of rye bread daily;
10 guinea pigs were given 250 grams of whole-wheat bread daily.

Harry noted that each guinea pig ate all the bread it was given. At the end of two weeks, he weighed each guinea pig to see how many had put on weight. His findings are shown below:

Type of bread eaten	Number of guinea pigs putting on weight
White	0
Rye	10
Whole-wheat	1

85 Which one of the following statements best fits the information given above about white and rye bread?

A Rye bread is better than white bread for making guinea pigs put on weight.
B White bread is better than rye bread for making guinea pigs put on weight.
C White bread and rye bread are equally as good for making guinea pigs put on weight.
D Whether white bread or rye bread is better for making guinea pigs put on weight cannot be determined from the information given.

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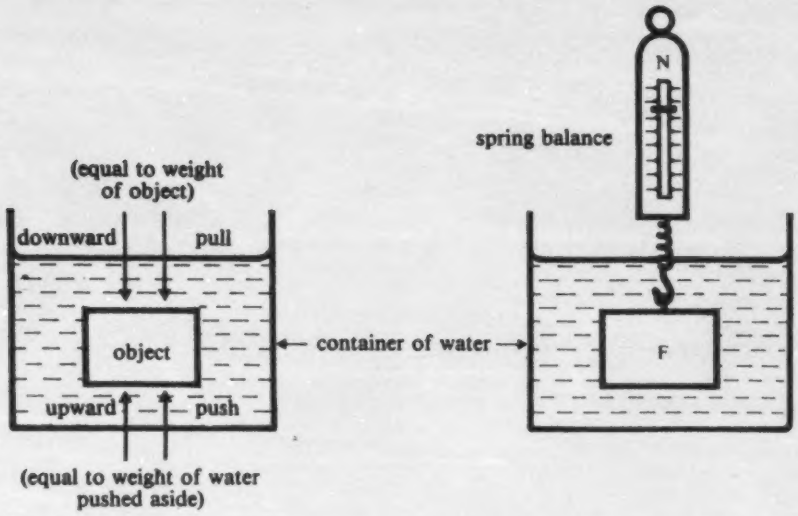
Question 86

The diagram below shows the two forces (push or pull) that act on an object when it is placed in water.



The downward pull on the object is equal to the weight of the object. The upward push is equal to the weight of the water that is pushed aside by the object.

Below are values of the weight of six different objects together with the weight of water which each pushes aside.

Object	Weight of object (Newtons)	Weight of water pushed aside (Newtons)
A	10	8
B	8	10
C	5	3
D	15	14
E	6	5
F	7	4

86 The information given above suggests that the object that would float in water is

A object A.
B object B.
C object C.
D object D.
E object E.

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Question 87

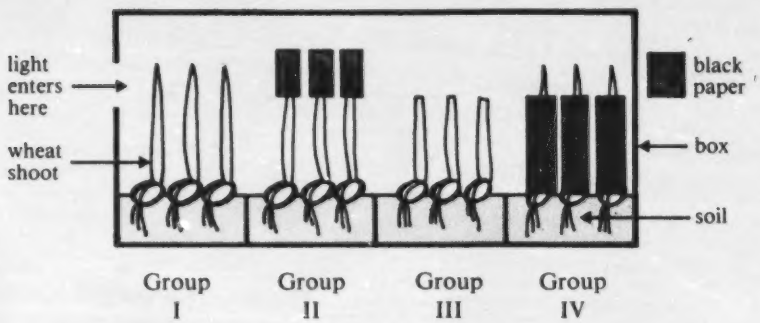
The apparatus in the diagram is used to test that wheat shoots grow towards light when light falls on their tips. There are four different groups of wheat shoots:

Group I ordinary wheat shoots

Group II wheat shoots with the tips covered with black paper

Group III wheat shoots with the tips cut off

Group IV wheat shoots with black paper covering all of the shoot except the tip



87 If it is true that wheat shoots grow towards light when light falls on their tips, which shoots would grow towards the light?

A Group II only

B Group IV only

C both Group I and Group II

D both Group III and Group IV

E both Group I and Group IV

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